A Systematic Approach To Abnormal Chest Images: Lung: CR, CT

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Overview

Presentation Format

Major CXR Patterns

Mass
Consolidative
Interstitial
Vascular
Airway

Systematic Process, Methodical

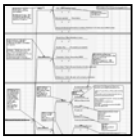
Lung volumes
Location/ distribution
Patterns (type of opacity)
DD General, then specific

Summary

Definitions
Patterns
DDG
DDS
Cases, examples

Overview

Presentation Format



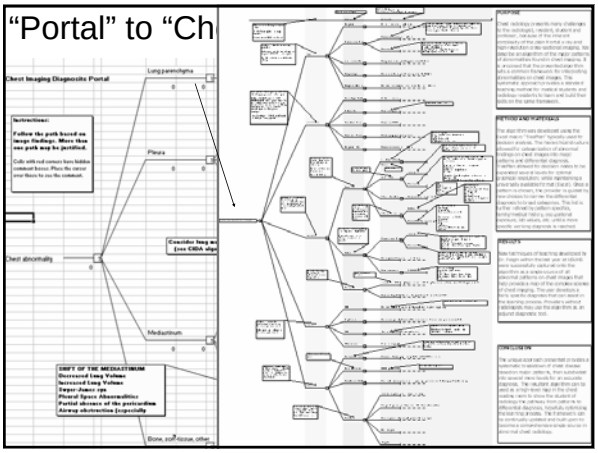
- Methodical image interpretation
  - In class, conference, communications and in practice
- Reference to XL algorithm:
  - 60,000-foot aerial view
  - Rather than GPS to specific differential dx
  - Eventually available on Palm and CE as AI
- Map throughout presentation to know topic
  - TX vs. FL, not meant to be read in presentation

Algorithm

Yellow-bordered topic heading

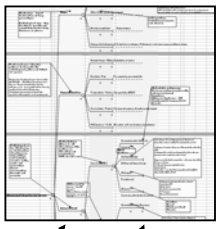
Overview

"Portal" to "Ch



Map

(Not written directions)



- Chest algorithm
- Pattern – is seen on images
  - The 5 major patterns **(BOLDFACE)**
  - Disease –seen on path specimens
- DDG: Differential Diagnosis, General
- DDS: Differential Diagnosis, Specific

Overview

Major Patterns of Abnormal Lung Markings

Dx

Most Dense

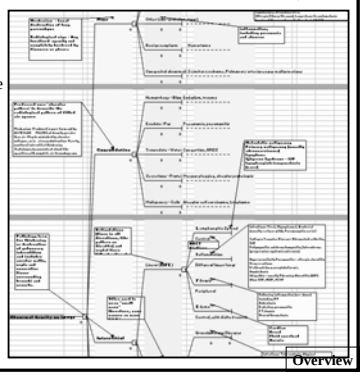
Mass

Consolidation

Interstitial

Vascular

Airway

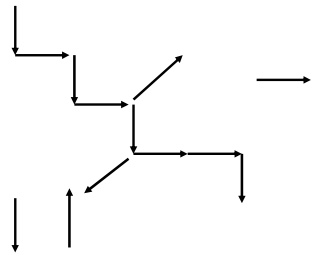


Overview

Image Reasoning

Time of thought

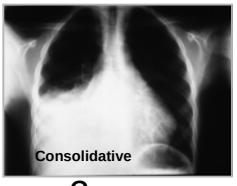
- **Mass**
- **Consolidation**
- **Interstitial**
- **Vascular**
- **Airway**



Pattern Location History SX DX

Overview

Click on the image that most resembles your unknown:



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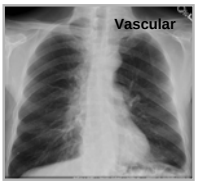

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5

Mass *

- **Mechanism** - Local destruction of lung parenchyma
- **Radiological sign** - Any localized opacity not completely bordered by fissures or pleura

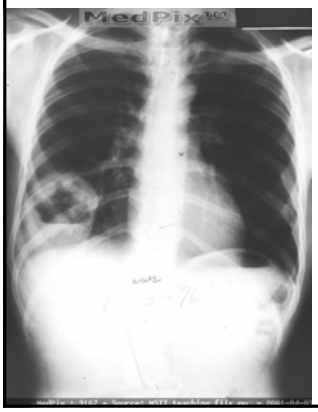
Mass

Mass Differential Diagnosis *

- Malignancy - Primary or secondary
- Granulomatous disease
  - Infectious or noninfectious
  - Active or inactive
- Other inflammation
  - including pneumonia; abscess
- Benign neoplasm
- Congenital abnormality

Mass

MedPix 3167 *



I: Rt lower lung field

D: Well rounded (marginated), thick wall, fluid level

C: Mass

D: Malignancy, inflammation

Mass

Bronchgenic carcinoma

- FINDINGS:
  A cavitated round opacity is present at the right lung base. It overlies the back of the heart shadow on the lateral view. There are nodular opacities inside the cavity and an air-fluid level is also visible. The location is thus right lower lobe, with possible involvement of the posterior portion of the middle lobe.

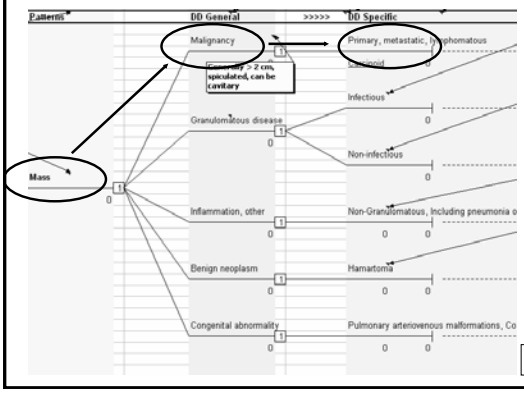
  PATTERN: The definition of a mass is satisfied.

  DIFFERENTIAL DIAGNOSIS:
  Malignancy is favored over inflammation because of the irregularity of the inner wall of the cavity. The air-fluid level is not useful in differential diagnosis; it indicates only that the bronchus connected to the mass is either partially or intermittently
  obstructed.

  DIAGNOSIS:
  Bronchogenic carcinoma, adenomatous

Mass

Mass DD: Malignancy Pathway



Mass

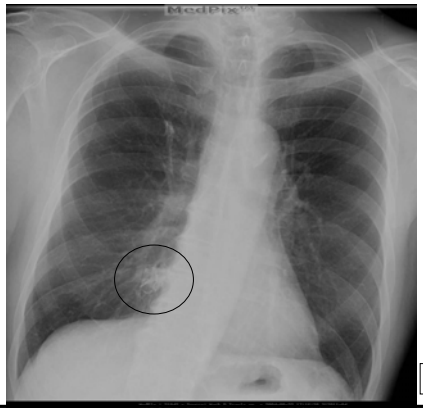
Malignancy: histological types

- Carcinoma (adenocarcinoma) (33%)
  - Bronchoalveolar cell carcinoma (BAC)
- Squamous cell (epidermoid) (30%)
- Large Cell carcinomas (4%)
  - usually classified as non-small cell types
- Small Cell carcinoma (13%)

Thompson WH. Respir Care. 2004 Nov;49(11):1349-53.
Bronchioloalveolar carcinoma masquerading as pneumonia. BAC

http://www.archbronconeumol.org/cgi-bin/wdbcgi.exe/abn/abneng.mrevista.fulltext?pident=13076438

MedPix 7507



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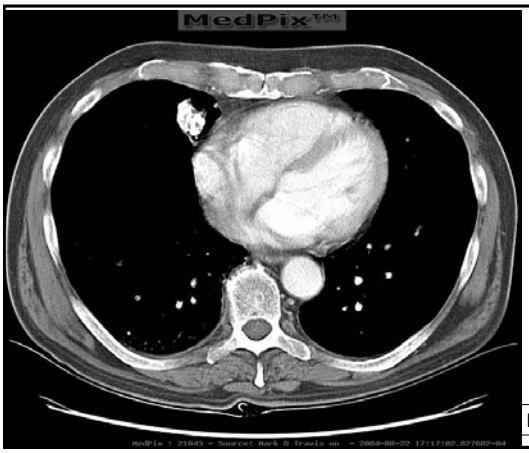


7507

Mass

Mass Considerations: Calcifications

- Crucial appearance characteristics for inactivity

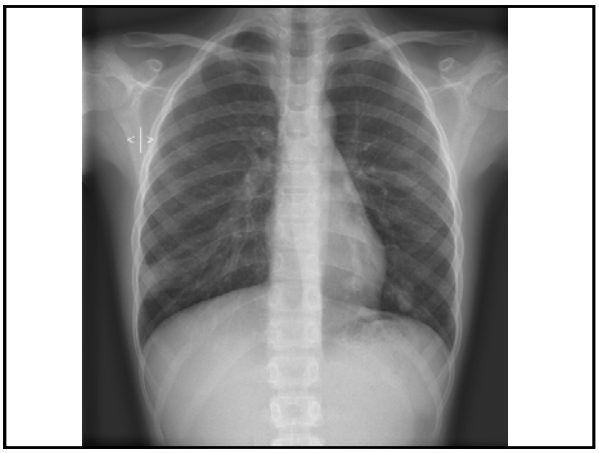
-**Calcification**
  - Central, lamellar
- **Evolution**
  - 2 year stability or regression

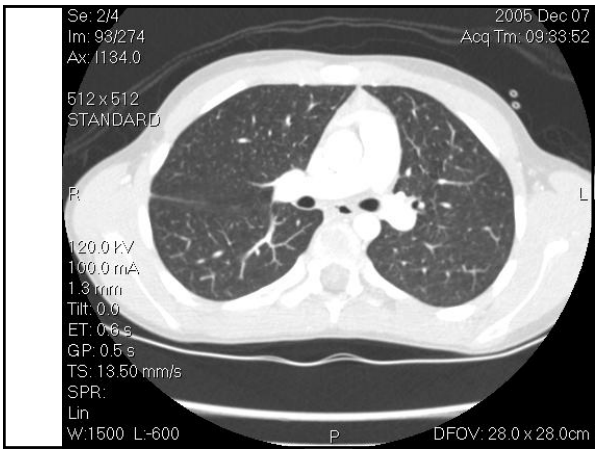
Mass

Pulmonary Hamartoma

- **Hamartomas are benign neoplasms**
  - **90% found in lung**
- **5% of all solitary lung nodules.**
- **CR demonstrate well-circumscribed peripheral rounded or lobulated tumor.**
- **Frequently contain cartilage with fibrous connective tissue and various amounts of fat, smooth muscle, and seromucous glands.**
- **Approximately 30% contain calcium usually of the "popcorn" variety.**
- **Seen most commonly in 4th and 5th decades of life.**
- **They are rare in children.**

Mass

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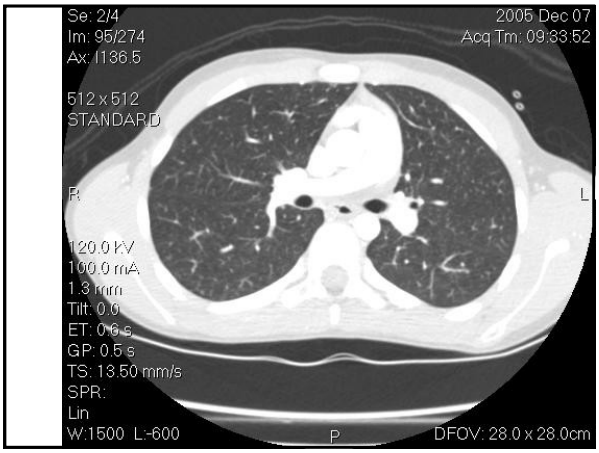
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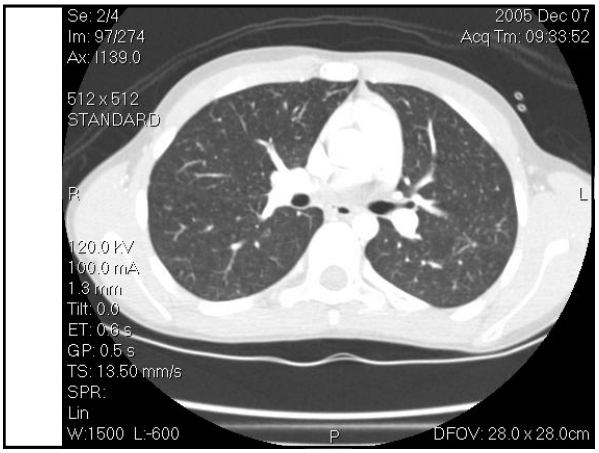
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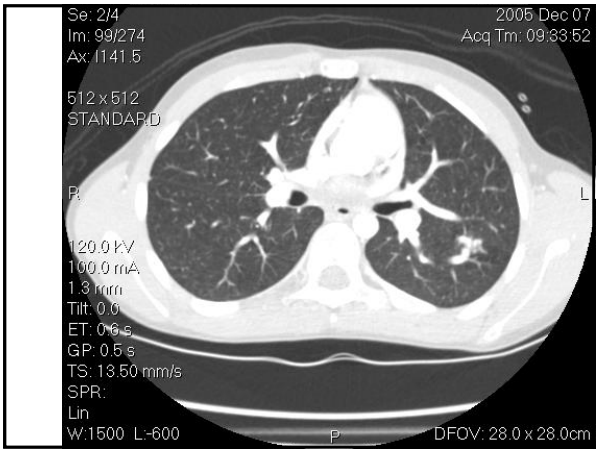
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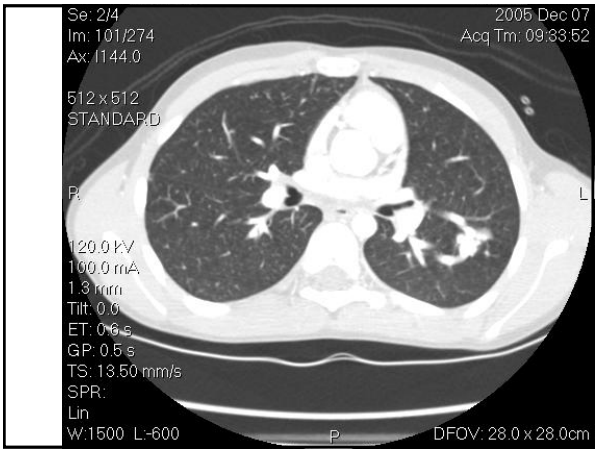
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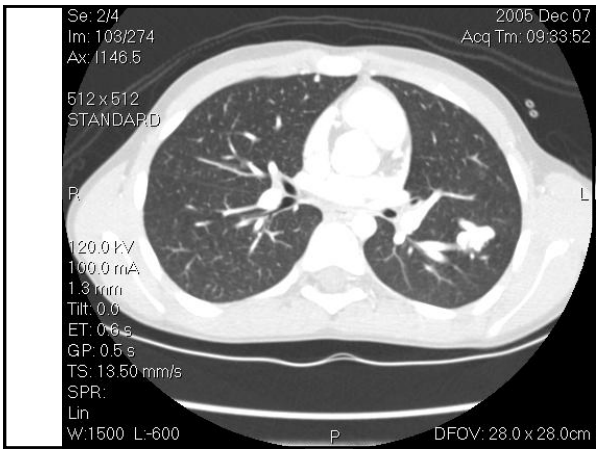
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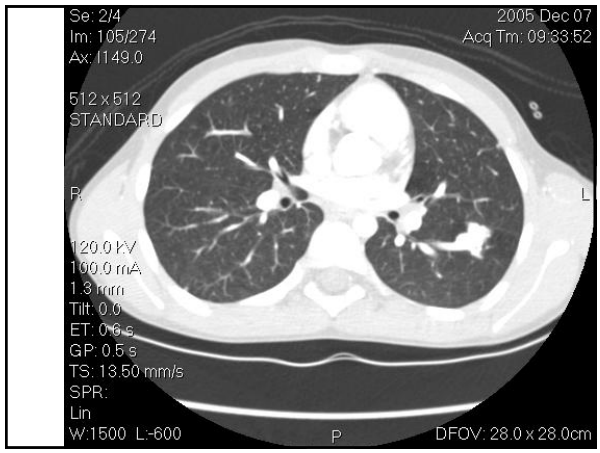
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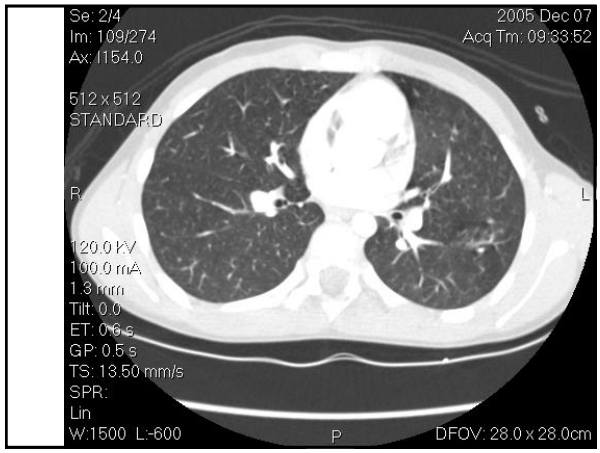
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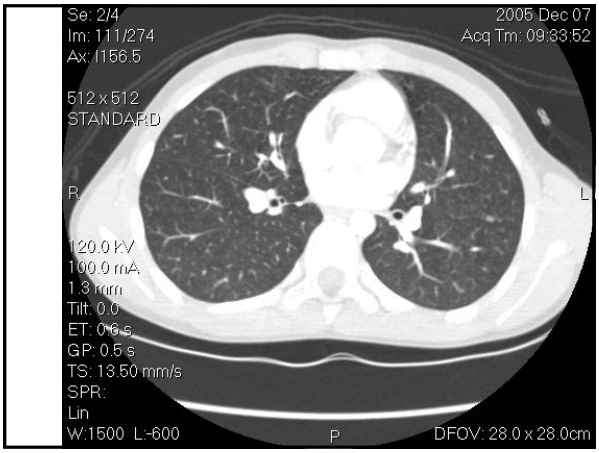
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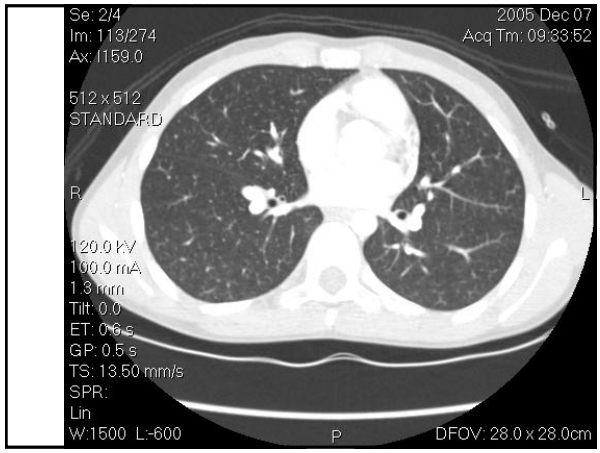
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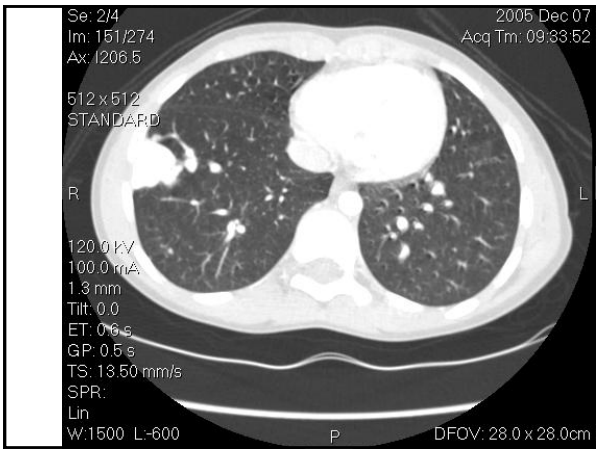
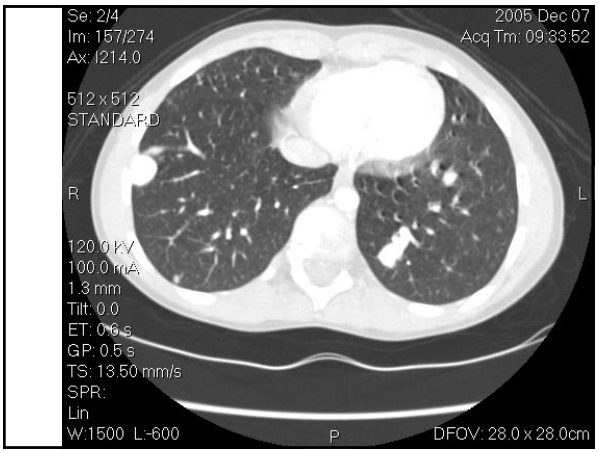
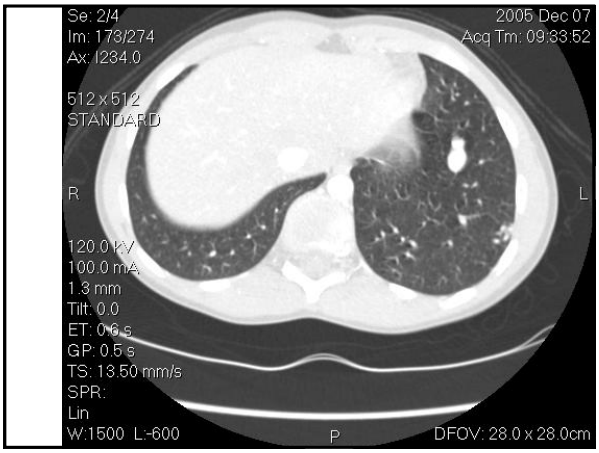






Pulmonary Arteriovenous Malformation

- **Pulmonary AVM's are abnormal connections between the pulmonary arteries and veins.**
- **They are single in 65%, multiple in 35%. Twice as common in women than men, the majority are congenital and are found in the lower lobes.**
- **Significantly, nearly 70% are associated with Hereditary Hemorrhagic Telangiectasia (Rendu-Osler-Weber disease), an autosomal dominant condition involving multiple AVM's in the brain, lung, skin, and liver.**

Mass

The CT scan in this patient is highly suggestive and limits the differential diagnosis to pulmonary AVM.

The DDX for pulmonary AVM's can further be subdivided to Hereditary Hemorrhagic Telangiectasia and hepatopulmonary syndrome as the two most common causes.

History and physical exam findings support pulmonary AVM's and more specifically HHT

Hereditary Hemorrhagic Telangiectasia

- Also called Rendu-Osler-Weber syndrome
- Autosomal Dominant inheritance
- Signs/Symptoms:
  - Epistaxis
  - Hemoptysis
  - Dyspnea
  - Clubbing
  - Skin telangiectasias
  - Gastrointestinal bleeding
  - Bruits/murmurs
  - High output CHF

Mass Considerations
The Topographic Map

Clinical variables	Symptoms and signs
Age, History Prior exams (CXR, CT) Location (in chest) Multiplicity?	Hemoptysis Coughing Dyspnea SOB
Risk factors -Smoking -Occupation, exposure hobbies -Previous carcinoma -Concurrent disease	*Mass DD is included in some vascular and nodular patterns* *Also works the other way around:* *Not always black and white*

Factors narrowing down the differential dx.

Mass

Consolidative (Alveolar) Pattern *

Con-SOLID-ative

Mechanism
- -Produced in pure form by **ALVEOLAR FILLING of density greater than air**
- -May be mimicked by alveolar collapse, as in airway obstruction
  - -Rarely, manifests w confluent interstitial thickening

Consolidative

Consolidative (alveolar) Pattern *Radiological signs:*

Fluffy, cloud-like, coalescent opacities

Can get sharp edges when limited by fissures or pleura

Complete air bronchograms

Distribution: lobar

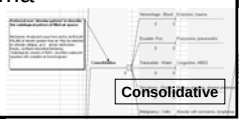
Obliterates pulmonary vasculature

Differentiates from “ground glass” (not SOLID)

Consolidative

Consolidative (alveolar) Pattern: Differential Diagnosis *

- Hemorrhage - **BLOOD** - embolism, trauma
- Exudate - **PUS** - pneumonia, pneumonitis
- Transudate - **WATER** - congestion, ARDS
- Secretions - **PROTEIN** - Mucous plugging, Alveolar proteinosis
- Malignancy - **CELLS** - Bronchoalveolar cell carcinoma (BAC), Lymphoma



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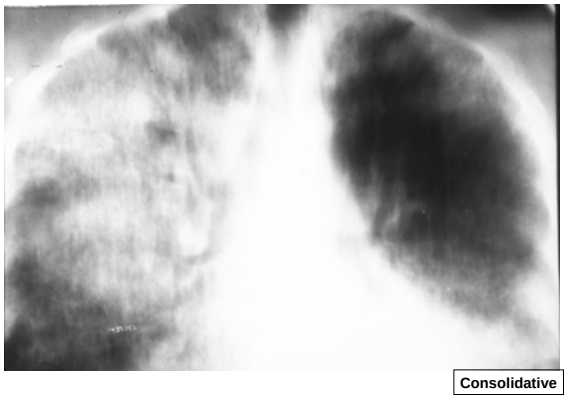

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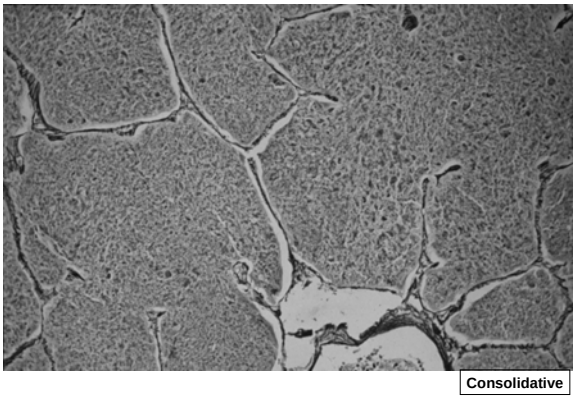
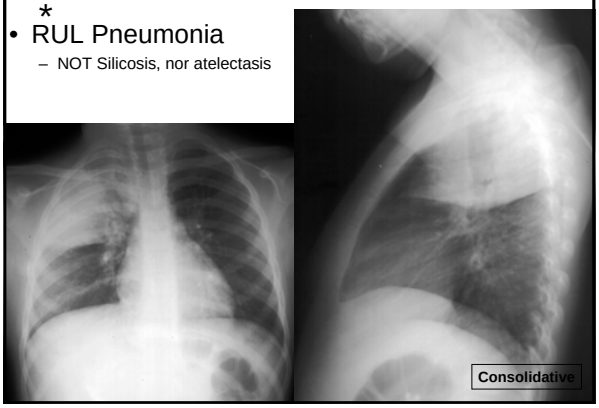


Consolidative

*
- RUL Pneumonia
  - NOT Silicosis, nor atelectasis



Consolidative

RUL Pneumonia

- Large area of opacification on the frontal view has both major and minor fissures as its inferior border.
- The lateral view demonstrates nicely the fissures of the right lung. Both RML and RLL remain well areated.
- MSU Top 10 CXR dx
  - www.rad.msu.edu/.../im_tutor/images/

Consolidative

Bacterial pneumonia

- **Streptococcus pneumoniae is the most common cause of bacterial pneumonia**
- **May present with mild to severe symptoms, including shaking chills, chattering teeth, severe chest pain, and a cough productive of rust-colored or greenish sputum**
- **May be febrile, diaphoretic, tachypneic, dyspneic, and/or cyanotic.**

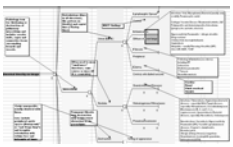
Consolidative

Consolidative

Consolidative

INTERSTITIAL PATTERN

- Mechanism: *
  - Thickening of lung interstices
  - Architectural destruction of interstitium
- Appearance: Lines, reticulations
  - That are not vasculature; in addition of



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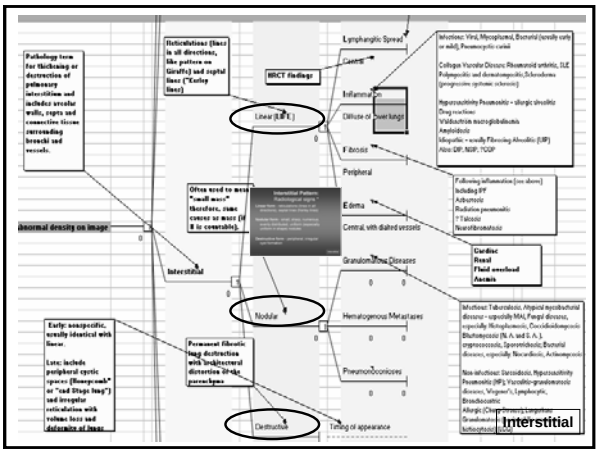


Interstitial

Interstitial Pattern:
Radiological signs *

Linear form - reticulations (lines in all directions), septal lines (Kerley lines)

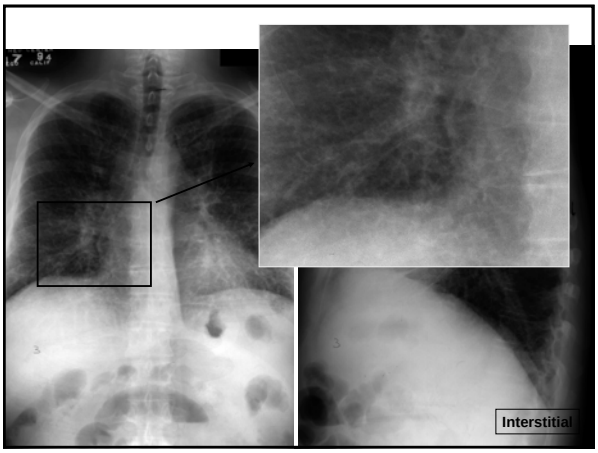
Reticulonodular

Nodular form - small, sharp, numerous, evenly distributed, uniform (especially uniform in shape) nodules

Destructive form - peripheral, irregular cyst formation

Interstitial

Interstitial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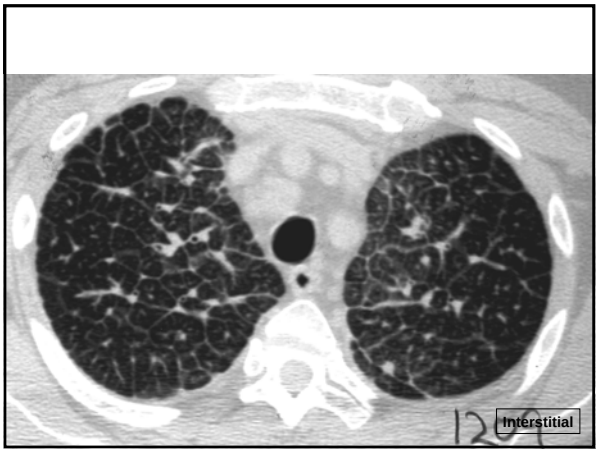
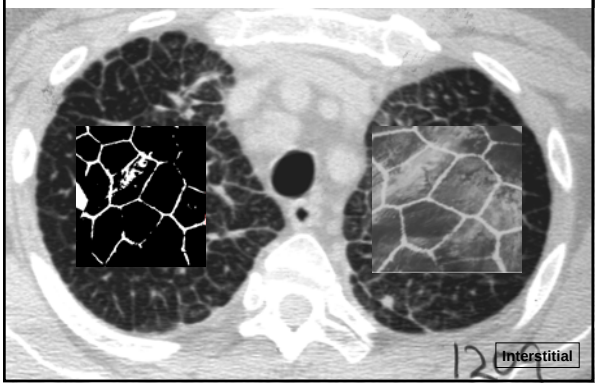
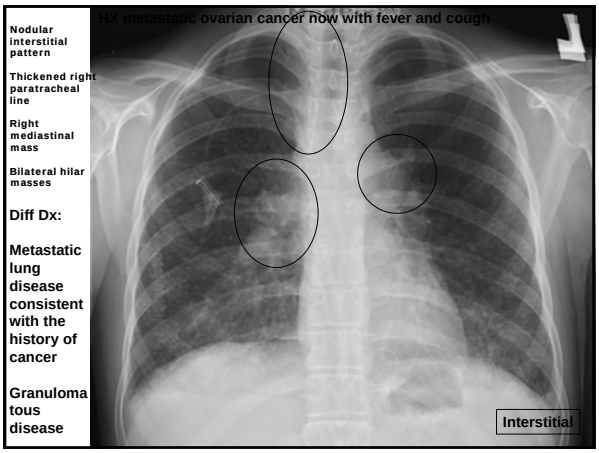
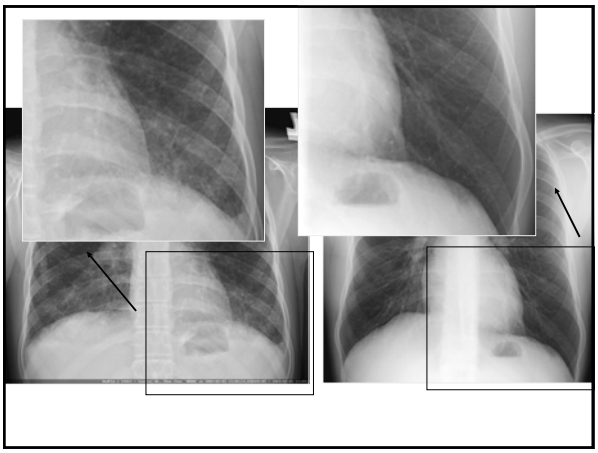
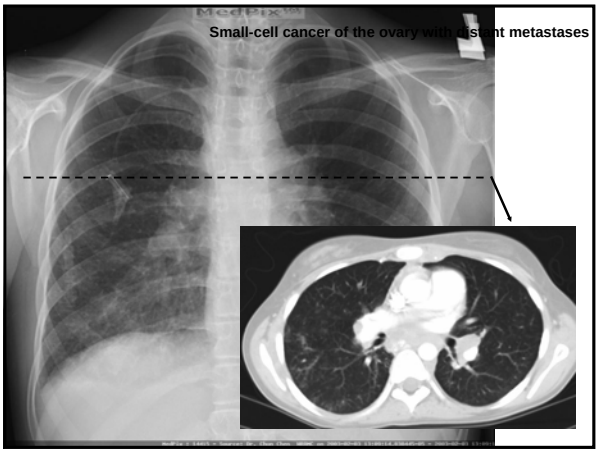

Interstitial

Lymphangitic Spread


Interstitial



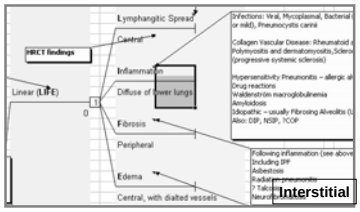




Interstitial Pattern Cont. Differential Diagnosis

- **Linear form - LIFE lines ***

  -Lymphangitic spread of malignancy
  -Inflammation
  -Fibrosis
  -Edema



LINEAR INTERSTITIAL PATTERN
Specific Differential Diagnosis

- **LYMPHANGITIC SPREAD**

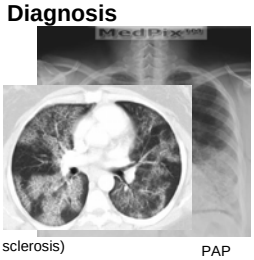
  – **Metastatic malignancy**
    - Primary malignancy
      – usually adenocarcinoma
    - Lymphoma (rarely)
    - Sjogrens syndrome – LIP
    - Lymphangioleiomyomatosis (rare)

Patterns → Interstitial → LIFE

LINEAR INTERSTITIAL PATTERN
Specific Differential Diagnosis

INFLAMMATION
Infections
Viral
Mycoplasmal
Bacterial (usually early or mild)
Pneumocystis carinii

Collagen Vascular Disease
Rheumatoid arthritis
SLE
Polymyositis and dermatomyositis
Scleroderma (progressive systemic sclerosis)



PAP

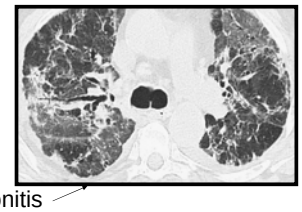
Hypersensitivity Pneumonitis – allergic alveolitis
Drug reactions
Waldenström macroglobulinemia
Amyloidosis
Idiopathic – usually **Fibrosing Alveolitis (UIP)**
Also: DIP, NSIP, ?COP

Patterns → Interstitial → LIFE

LINEAR INTERSTITIAL PATTERN
Specific Differential Diagnosis

- **FIBROSIS**

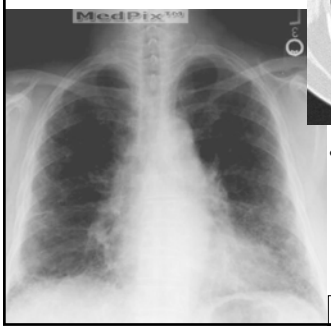
Following inflammation
Including IPF
Asbestosis
Radiation pneumonitis
? Talcosis
Neurofibromatosis

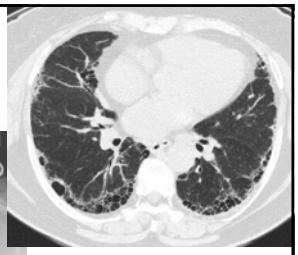


Hypersensitivity Pneumonitis

Patterns → Interstitial → LIFE

Idiopathic Pulmonary Fibrosis





- MedPix

Patterns → Interstitial → LIFE

LINEAR INTERSTITIAL PATTERN
Specific Differential Diagnosis

EDEMA

- Cardiac
- Renal
- Fluid overload
- Anemia

Mnemonic: NOT CARDIAC:

- Near drowning
- Oxygen therapy
- Transfusion or Trauma (fat embolism)

- Central nervous system disorder
- Allergic alveolitis
- Renal failure
- Drugs
- Inhaled toxins
- Aspiration or ARDS or Altitude sickness
- Contusion

Patterns → Interstitial → LIFE

MedPix 9067 (COW);
HX: 17 y/o M in ED w Heroin overdose

Interstitial

Findings, DX

- Bilateral patchy diffuse opacities predominantly in mid to upper lung fields
- DDG:
- • Noncardiogenic pulmonary edema
  • Cardiogenic pulmonary edema
  • Allergic reaction
  • Lymphangitic spread
- DDS:
- **Noncardiogenic Pulmonary Edema**

http://rad.usuhs.mil/medpix/parent.php3?mode=cowpt&pt_id=9067&case=&recnum=0&imid=27311&showall=yes&hx=yes&dx=yes&th=1#diagnosis

http://radiographics.rsnajnls.org/cgi/content/full/19/6/1507

Interstitial

Interstitial Pattern Cont. Differential Diagnosis

- **Nodular form**

Granulomas
Hematogenous spread of malignancy
Pneumonoconiosis

Since nodules are essentially small masses, include mass differential

Patterns → Interstitial → Nodular

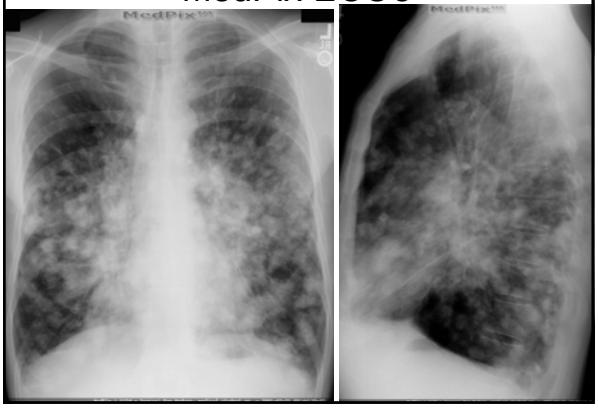
Squamous cell carcinoma identified by open lung biopsy after failed transbronchial biopsy.

* Differential:
  - Miliary TB
  - Viral pneumonia
  - Metastatic carcinoma
  - Sarcoidosis

MedPix 2589

http://rad.usuhs.mil/medpix/medpix.html?mode=pt&pt_id=2589&case=&recnum=1222&imid=1125&find=-1&ddx=-1&showall=yes&hx=&th=1&dx=-1#diagnosis

MedPix **2589**

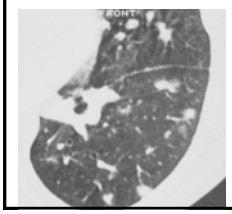


INTERSTITIAL PATTERN: Nodular
Specific Differential Diagnosis

Granulomatous Diseases

Infectious

- Tuberculosis (miliary example below)
- Atypical mycobacterial diseases - especially MAI



Patterns → Interstitial → Nodular

Miliary Nodular
INTERSTITIAL PATTERN MedPix

- TEMPEST

T TB, FUNGAL, VIRAL PNEUMONIAS
E EG
M METS (THYROID, RENAL)
P PNEUMOCONIOSES, PARASITES
E EMBOLISM OF OILY CONTRAST (LIPOID PNEUMONIA)
S SARCOIDOSIS, SILICOSIS
T TUBEROUS SCLEROSIS

Interstitial

Active Pulmonary TB: MedPix *

DDG:
TB or other granulomatous process
Pneumonoconioses

INTERSTITIAL PATTERN: Nodular
Specific Differential Diagnosis

Granulomatous Diseases
- Fungal diseases, especially:
  - Histoplasmosis
  - Coccidioidomycosis
  - Blastomycosis (N. A. and S. A.)
  - Cryptococcosis
  - Sporotrichosis
- Bacterial diseases, especially:
  - Nocardiosis
  - Actinomycosis

Patterns → Interstitial → Nodular

INTERSTITIAL PATTERN: Nodular
Specific Differential Diagnosis

Granulomatous Diseases

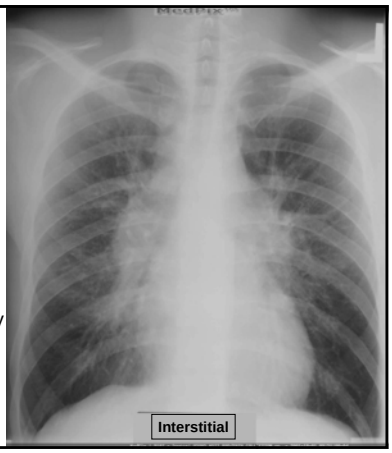
Non-infectious
- Sarcoidosis
- Hypersensitivity Pneumonitis (HP)
- Vasculitis-granulomatosis diseases
  - Wegener's
  - Lymphocytic
  - Bronchocentric
  - Allergic (Churg-Strauss)
- Langerhans Granulomatosis (LCG)
  - (Previously EG, histiocytosis X)

Patterns → Interstitial → Nodular

MedPix 4017

Bilat hilar adenopathy

DDG:
- Sarcoid
- Lymphoma
- Bronchogenic CA
- Mets
- Other inflammatory



Interstitial

Sarcoid
MedPix 4017

- **A** granulomatous disease of unclear etiology, most commonly recognized by its thoracic manifestations of interstitial lung disease and hilar and mediastinal adenopathy.
- A multisystem disease, with histologic evidence of **sarcoid** involvement of the liver and spleen seen in 50-80% of all surgical specimens, although most cases do not result in organ dysfunction.

Interstitial

Pneumoconioses

- B CHAOS: *
  - Berylliosis
  - Coal worker's Pneumoconioses
  - Hard metal disease
  - Asbestosis
  - Others
  - Silicosis

Patterns → Interstitial → Nodular

Interstitial Pattern

Destructive form

Early appearance is nonspecific

Late findings include peripheral cystic spaces
- Honeycomb or "End Stage Lung" with volume loss and deformity of lungs

- Chronic ILD: Low lung volumes
- No airway wall thickening

Patterns → Interstitial → Destructive

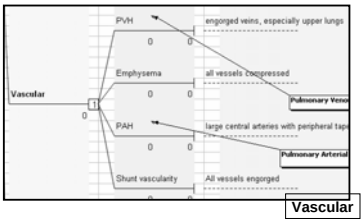
VASCULAR PATTERN

- **Mechanism** - increased or decreased perfusion altering diameter (hence appearance) of pulmonary vessels

Larger diameter:
Big vessels

Smaller diameter:
Disappearance
More lucent

(Not displacement)



Vascular

Vascular Pattern DDG: Examples *

- Common examples
  - -**Congestion** - engorged veins, especially upper lungs
  - -**Emphysema** - diminished vessels
  - -**Shunt vascularity** - all vessels enlarged
  - -**Lymphangitic carcinoma** - irregular infiltration around vessels may resemble vessel enlargement

Vascular

Vascular Pattern DDG: Examples, cont. *

Pulmonary Arterial hypertension - large central arteries with peripheral tapering

Thromboembolism - locally diminished vessels sometimes with large central vessels

Bronchial circulation - irregular vessels in unusual directions

Vascular

PAH vs. PVH

Pulmonary Arterial Hypertension

enlarged central and hilar vessels (best seen on lateral)
enlarged middle mogul on PA
pruned peripheral vessels (tapering to diminished)
mosaic perfusion (CT)
cor pulmonale
PA atherosclerosis

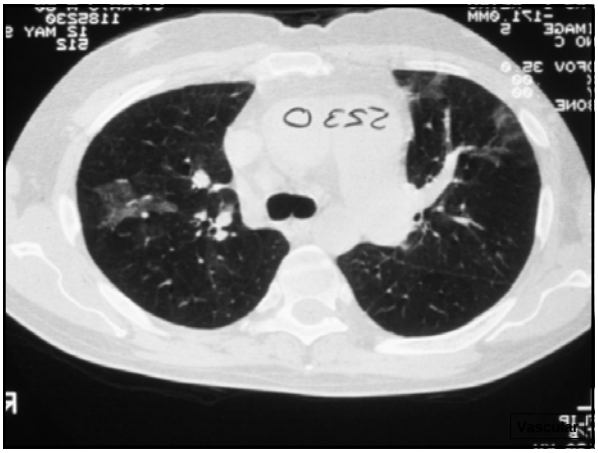
Pulmonary Venous Hypertension

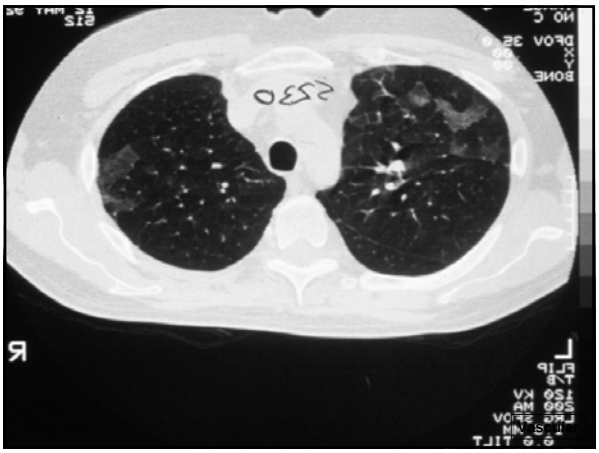
septal lines
smooth pleural thickening
pleural effusion
ground glass opacity
dilated vessels, especially upper lungs
hilar arteries not enlarged

Vascular

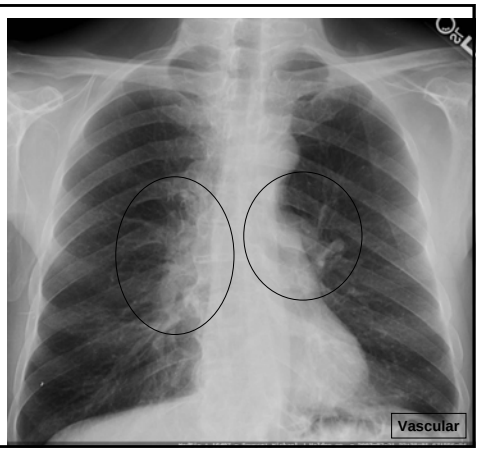
Vascular

Vascular



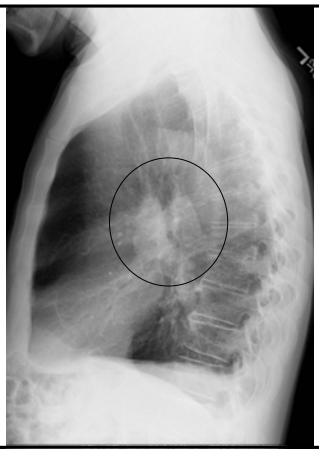


MedPix 6149



Vascular

Pulmonary arterial hypertension



Vascular

AIRWAY (BRONCHIAL) PATTERNS

- Mechanism:
- Complete or partial obstruction of airways
- Thickening of airway walls
  - or displacement of vessels due to overaeration, COPD, etc.

Airway

Airway (bronchial) Pattern; Major Forms:

Complete airway obstruction

- opacity and decreased volume

Partial obstruction

- lucency and increased volume

Wall thickening

Show up as “tram tracks” *

Bronchiolar (small airway) obstruction

Airway

Complete airway obstruction

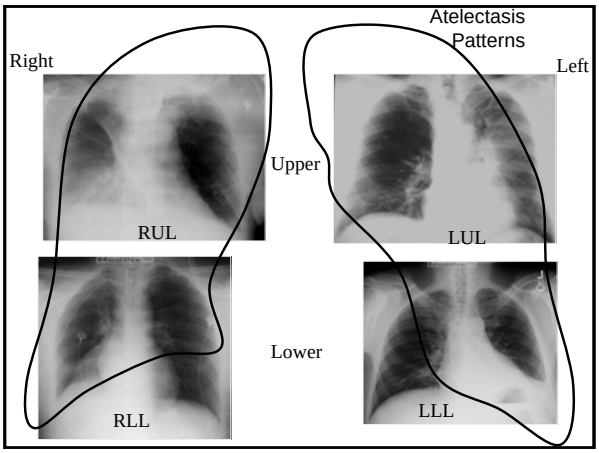
Opacities

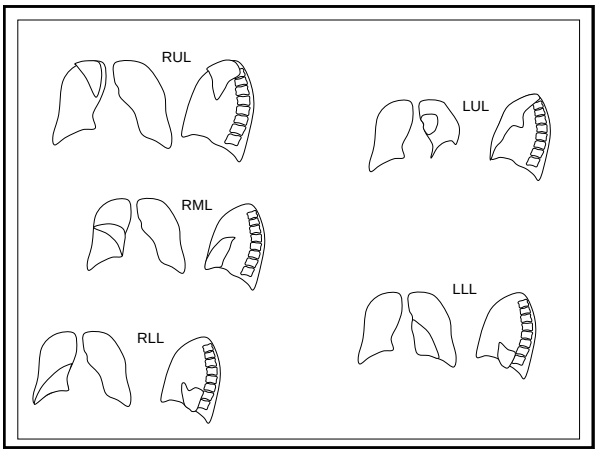
endobronchial malignancies, granulomas, inflammatory, benign or congenital masses, mucous plugs, foreign bodies

Decreased volume (atelectasis)

- can resemble mass or consolidation

Airway Complete

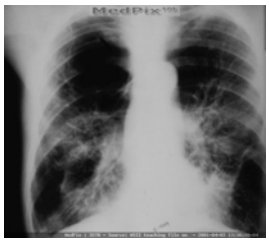


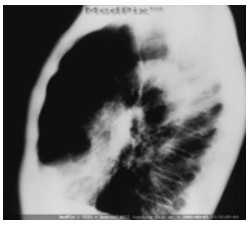


Partial airway obstruction

-**Lucencies**

- COPD, cysts, blebs, pneumatoceles





Airway | Partial

COPD with bullous emphysema

- FINDINGS:

  The lungs are hyperinflated and the diaphragms are markedly flattened, especially on the lateral view. There are numerous lucent "holes" in the lungs and the vessels are displaced and asymmetrical.

  PATTERN:

  Air trapping is present, especially in multiple bullae with thin walls. These are the findings of bullous emphysema. Most such patients have COPD, the most common of all airway diseases.

  DIFFERENTIAL DIAGNOSIS:

  A few emphysematous patients have normal airways, with abnormal elasticity of alveolar walls, such as in alpha one antitrypsin deficiency.

  DIAGNOSIS: COPD with bullous emphysema

  Airway

- http://rad.usuhs.mil/medpix/medpix.html?mode=single&recnum=1696&th=-1#top

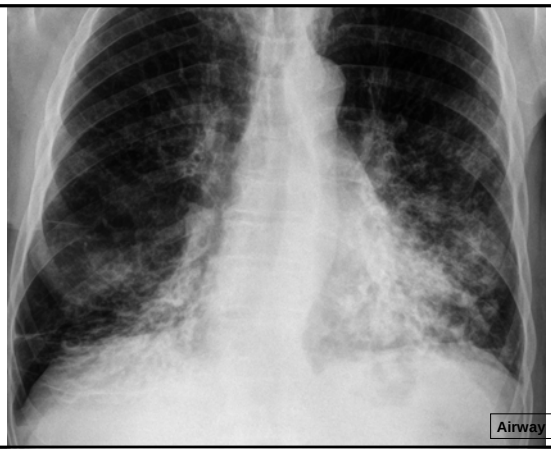
DESTRUCTIVE AIRWAY DISEASE: **BRONCHIECTASIS**

Thickening - bronchiectasis, chronic bronchitis

- Central (perihilar) cystic spaces, increased lung volumes and thickened airway walls
  - circles and tram tracks
- Distinct from destructive interstitial disease

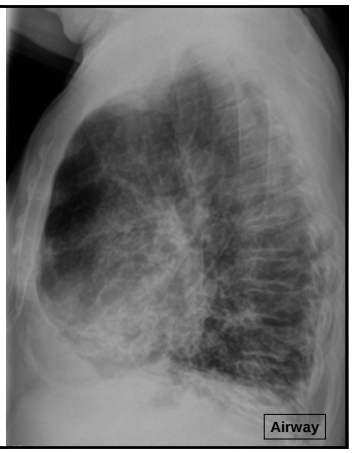
Note that air is the majority of the finding in airway pattern and density (bronchial walls) are the exception;
as opposed to consolidation.

Airway | Wall thickening



Airway

- **Bronchiectasis**



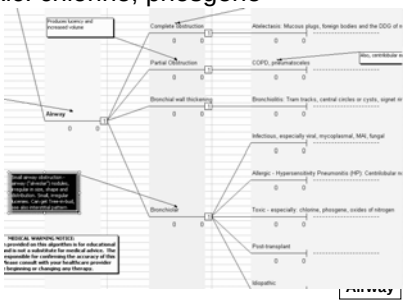
Airway

Examples of bronchiolitis

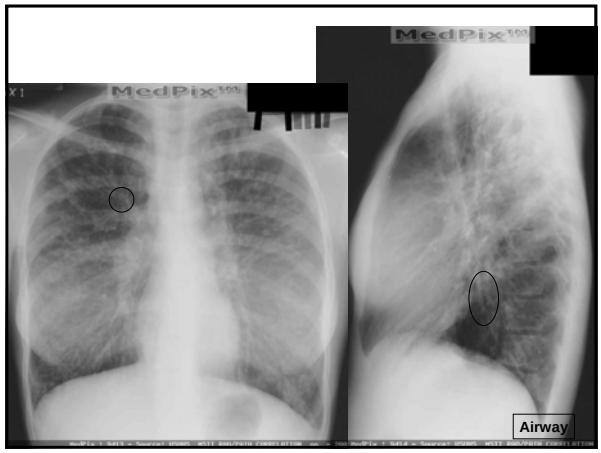
-Infectious - e.g., Viral, mycoplasmal

-Allergic: Toxic: chlorine, phosgene

-Idiopathic



Airway



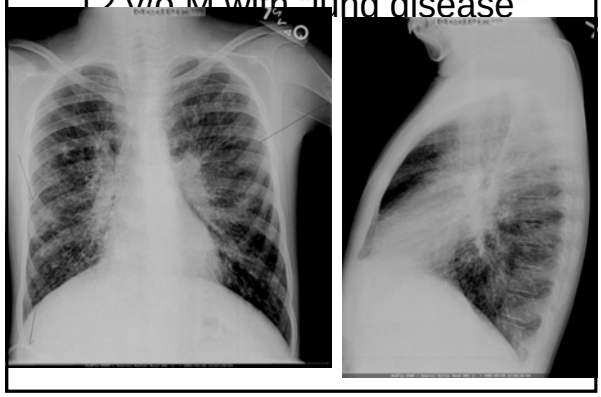
Airway

MedPix 9413 Cystic Fibrosis

- **The radiographic findings are largely secondary to the bronchial obstructions by the thick adherent secretions. Pulmonary hyperinflation is evidenced in this case by the narrow heart and mediastinum and the slightly depressed diaphragm.**
- **The hila are prominent and there, is lobulated contour of the right hilum consistent with the presence of adenopathy which is common in these patients. The most prominent findings in this patient are the changes related to bronchiectasis.**
- There is bronchial wall thickening seen as bronchial cuffing or "tram lines". Dilated bronchi are particularly well seen in the upper lungs where widened tubular and branching lucencies can be seen peripherally some of which containing tubular opacities representing impacted mucus.

Airway

12 y/o M with "lung disease"



Cystic Fibrosis - End-Stage

- **Pt with end stage cystic fibrosis with pulmonary colonization with pan-resistant Pseudomonas cepacia.**

Bronchiolar (small airway) obstruction

Airway ("alveolar") nodules:
irregular in size, shape and distribution

- Small, irregular lucenies. Can get Tree-in-bud, see also interstitial pattern

Airway | Bronchiolar

Airway Patterns: CT

-Thick-walled airways: "tram tracks"
circular on end: "signet rings"

-Cystic spaces centrally located

-Cystic spaces with very thin walls or no apparent walls

-Thin, stretched vessels

Airway

Summary

Presentation Format

Major CXR Patterns

Mass
Consolidative
Interstitial
Vascular
Airway

Systematic Process, Methodical

Lung volumes
Location/ distribution
Patterns (type of opacity)
DD General, then specific

Definitions
Patterns
DDG
DDS
Cases, examples

Overview

References

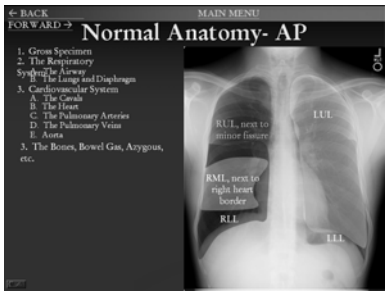
http://rad.usuhs.mil/rad/handouts/ms-2_final.html

Case Studies: http://rad.usuhs.mil/rad/handouts/feigin/abnlcxr/myindex.htm

3 D anatomy:
http://vertex.biostr.washington.edu/cgi-bin/DA/imageform

Review Materials

- Chest Primer
- Anatomy
- MedPix

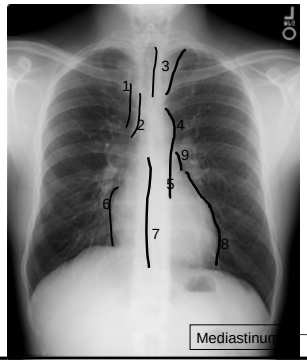


Review: Mediastinum Lines, Edges

Recommendation:

Test yourself before advancing to next slide

1. **SVC Edge**
2. **Rt Paratracheal Line**
3. **Lt Paratracheal Stripe**
   (both red and black lines)
4. **Aortic Arch**
5. **Descending Aorta**
   (only left edge seen, and not always)
6. **Rt Atrium**
7. **Azygoesophageal edge**
8. **Lt Ventricle**
9. **Main Pulmonary Artery**
   AKA: trunk, middle mogul



Mediastinum → Mid